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Atty. Docket No. CPAC 1014-4
Appl. No. 10/608,843

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Taekun LEE *et al.*	Examiner: Khiem D. Nguyen
Application No.: 10/608,843	Group Art Unit: 2823
Filed: June 27, 2003	Date: June 23, 2005
Title: (Amended) **Method for manufacturing plastic ball grid array with integral heatsink**	

CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that this correspondence is being facsimile transmitted to Examiner Nguyen in the United States Patent and Trademark Office, at the Central Fax no. 703-872-9306 on June 23, 2005.

Signed ________________
Bill Kennedy

COMMISSIONER FOR PATENTS
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AMENDMENT

Dear Sir:

In response to the Advisory Action mailed 22 June 2005, kindly amend the application as follows.

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims are reflected in the **Listing of Claims** which begins on page 3 of this paper.

Remarks begin on page 5 of this paper.

Amendments to the Specification

Please replace the title with the following new title:

-- Method for manufacturing plastic ball grid array with integral heatsink --

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This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims

1. (canceled)

2. (currently amended) A method for manufacturing a plastic ball grid array package, comprising

placing a heat spreader having an upper portion and a plurality of support arms into a mold cavity, the heat spreader being made of metal;

placing over the mold cavity a ball grid array including a semiconductor die mounted on a support surface of a substrate and connected to the substrate, such that lower ends of the support arms contact the support surface of the substrate peripheral to the die;

injecting molding material into the cavity; and

permitting the molding material to harden to form a mold cap;

the method further comprising treating an undersurface of the metal heat spreader to form a black copper oxide layer prior to injecting the molding material, the black copper oxide layer enhancing adhesion between the undersurface of the heat spreader and the mold cap.

3. (original) The method of claim 2 wherein the treating comprises exposing a copper undersurface of the heat spreader with $NaClO_2$ to form a black copper oxide layer.

4. (original) The method of claim 2 wherein the treating comprises exposing the copper undersurface of the heat spreader with $NaClO_2$ under conditions sufficient to form a black copper oxide layer having a thickness in the range 3 um to 15 um.

5. (original) The method of claim 4 wherein the treating comprises exposing the copper undersurface of the heat spreader with $NaClO_2$ under conditions sufficient to form a black copper oxide layer having a thickness of 7 um.

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6. (currently amended) The method of claim [[1]] 2 wherein the heat spreader is made of metal, and further comprising treating an undersurface of the metal heat spreader to roughen the undersurface prior to injecting the molding material.

7. (original) The method of claim 6 wherein the treating comprises micro-etching the copper undersurface of the heat spreader.

8. (original) The method of claim 7 wherein the treating comprises micro-etching the copper undersurface of the heat spreader to a roughness in the range 0.5 um to 1.0 um.

9. (original) The method of claim 8 wherein the treating comprises micro-etching the copper undersurface of the heat spreader to a roughness of 0.5 um.

10. (original) A method for manufacturing a plastic ball grid array package, comprising

placing a heat spreader having an upper portion and a plurality of support arms onto the die support surface of a substrate such that at least one of the supporting arms of the heat spreader is affixed to the substrate using a resilient fixative such as an elastomeric adhesive;

placing a mold cavity over the heat spreader;

injecting the molding material into the cavity; and

permitting the molding material to harden to form a mold cap.

11. (currently amended) The method of claim 10 wherein the heat spreader is made of metal, and further comprising treating an undersurface of the metal heat spreader to form a black copper oxide layer prior to placing the heat spreader onto the die support surface of the substrate, the black copper oxide layer enhancing adhesion between the undersurface of the heat spreader and the mold compound.

12. (original) The method of claim 11 wherein the treating comprises exposing a copper undersurface of the heat spreader with $NaClO_2$ to form a black copper oxide layer.

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13. (original) The method of claim 11 wherein the treating comprises exposing the copper undersurface of the heat spreader with $NaClO_2$ under conditions sufficient to form a black copper oxide layer having a thickness in the range 3 um to 15 um.

14. (original) The method of claim 13 wherein the treating comprises exposing the copper undersurface of the heat spreader with $NaClO_2$ under conditions sufficient to form a black copper oxide layer having a thickness of 7 um.

15. (original) The method of claim 10 wherein the heat spreader is made of metal, and further comprising treating an undersurface of the metal heat spreader to roughen the undersurface prior to injecting the molding material.

16. (original) The method of claim 15 wherein the treating comprises micro-etching the copper undersurface of the heat spreader.

17. (original) The method of claim 16 wherein the treating comprises micro-etching the copper undersurface of the heat spreader to a roughness in the range 0.5 um to 1.0 um.

18. (original) The method of claim 17 wherein the treating comprises micro-etching the copper undersurface of the heat spreader to a roughness of 0.5 um.

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Remarks

Status of Prosecution

On May 9, 2005, Applicants filed a response to an Office action, made Final.

An Advisory action, over the signature of Examiner Coleman, was mailed May 17, 2005 (the "First Advisory"). The First Advisory appeared to Applicants' representative, undersigned, not to have adequately addressed the arguments presented in the May 9, 2005 Amendment and, accordingly, Applicants' representative telephoned Examiner Coleman to discuss the case. Examiner Coleman agreed to review the matter and, on June 6, 2005, Examiner Coleman discussed the case with Applicants' representative by telephone (the "Telephone Interview").

Substantially, Examiner Coleman stated that he would ask Examiner Nguyen to send a new Advisory action, in which certain claims would be deemed allowed, or allowable.

There followed another Advisory action (the "Second Advisory"), which, it is presumed, replaces the First Advisory.

This Amendment responds to the Second Advisory. This Amendment presumes that none of the amendments in Applicants' May 9, 2005 response to the Final Office action have been entered. Accordingly, this Amendment makes claim amendments based upon the condition of the claims as they existed prior to the Final Office action, and restates the arguments made in the May 9, 2005 response, in light of the claim amendments herein.

Claim 1 is cancelled herein, without disclaimer or prejudice to Applicants' right to seek claims to the cancelled subject matter by way of one or more continuing applications, and claim 2 is amended to incorporate the limitations of claim 1 and to include a recitation of treatment of the heat spreader to form a black copper oxide layer which enhances adhesion of the heat spreader with the molding. Claim 6 is amended to depend from claim 2. Claim 11 is amended to recite that the black copper oxide layer enhances adhesion of the heat spreader with the molding. The Title is amended to more accurately describe the invention. No new matter is introduced by any of the amendments, and entry thereof is requested.

Claims 2 - 18 are in the application.

Reconsideration of the application, as amended, is requested.

The points raised in the Office action will now be addressed.

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Rejections under 35 U.S.C. § 102(b)

Claims 1 and 10 were rejected under 35 U.S.C. § 102(e) as being anticipated by Huang et al. U.S. 6,400,014 ("Huang"). The Examiner substantially repeats the same assertions and arguments as in the previous Office action.

As to claim 1

Claim 1 is canceled herein, to put the application in condition for allowance. Claim 1 is canceled without disclaimer or prejudice to Applicants' right to prosecute claims to the subject matter of claim 1 by way of one or more continuing applications.

[It is nevertheless noted, as Applicants pointed out earlier, that Huang describes heat sinks (Figs. 3 – 7) and completed semiconductor packages having a heat sink (Figs. 1, 8, 9). **Huang is silent as to method or process, except as to resin flow**. Particularly, Huang says nothing about placing the heat sink into a mold cavity and then (in a subsequent step) placing the ball grid array over the cavity, as recited in the claim. In "Response to Applicants' Amendment and arguments" in the Final Office action the Examiner pointed out that the claims do not recite that the ball grid array is placed over the mold cavity "in a subsequent step" following placing the heat spreader into the mold cavity, and noted that limitations from the specification will not be read into the claims. Applicants agree that claim 1 as filed did not recite "a subsequent step" in those words, but it is clear from the claim as filed, even without that recitation, that the step of placing the BGA over the mold cavity must necessarily follow the step of placing the heat sink over the mold cavity. That is because the step of "placing over the mold cavity a ball grid array including a semiconductor die mounted on a support surface of a substrate and connected to the substrate, such that lower ends of the support arms contact the support surface of the substrate peripheral to the die" expressly requires that the "heat spreader having an upper portion and a plurality of support arms" have already been placed into the mold cavity. Otherwise there would be no support arms for the BGA to contact. Accordingly the Examiner's assertion in the Advisory that this changes the scope of claim 1 and requires further consideration and new search is not well founded.]

As to claim 10

As to claim 10, this rejection is again traversed.

Particularly, contrary to the Examiner's assertion, Huang says nothing as to at least one supporting arm of the heat spreader being affixed to the substrate using a resilient fixative, as

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recited in the claim. In "Response to Applicants' Amendment and arguments", the Examiner pointed to Huang col. 3, line 53 to col. 4, line 9, and FIG. 1 as supporting an assertion that "Huang discloses that the heat spreader 33 being affixed to the substrate using a resilient fixative." The cited passage reads as follows:

> Please refer to FIG. 1, it is a cross-sectional view of the semiconductor package of the present invention. The semiconductor package 3 includes a substrate 30, a chip 31 adhered to the substrate 30, a plurality of gold wires 32 electrically connected to the substrate 30 and the chip 31, and a heat sink 33 disposed on the substrate 30, a resin body 34 for encapsulating the chip 31, the gold wire 32, and a portion of the heat sink 33, and a plurality of solder balls 35 mounted on the bottom surface of the substrate 30.
>
> The substrate 30 has a top surface 300 for laying out a plurality of metal traces (not shown because this is a well-known design), a bottom surface 301 for laying out a plurality of metal traces, and a plurality of vias (not shown) for electrically connecting the plurality of metal traces on the top surface 300 with those on the bottom surface 301. The solder balls 35 are respectively mounted at the ends of the metal traces on the bottom surface 301 for electrically connecting the chip 31 and the substrate 30. Therefore, the chip can be electrically connected with an external device such as a printed circuit board through the solder balls 35. The substrate is made of a material selected from a group consisting of epoxy resin, polyimide resin, triazine, a ceramic material, and a glass material, preferably bismaleimide triazine.

Applicants are unable to find here (or elsewhere in Huang) any suggestion, much less any teaching, of at least one of the supporting arms of the heat spreader being affixed to the substrate using a resilient adhesive, as recited in Applicants' claim 10.

Examiner Coleman agreed in the Telephone Interview that Huang does not teach an elastomeric adhesive.

Accordingly, Huang does not teach all the elements of Applicants' claims, and the rejections of claim 10 (and claims depending from claim 10) as being anticipated by Huang should be withdrawn.

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Rejections under 35 U.S.C. § 103(a)

Claims 2 – 9 and 11 – 18 were rejected under 35 U.S.C. § 103(a) for obviousness over Huang in view of Brestel U.S. 5,328,811 ("Brestel"). The Examiner substantially repeats the same assertions and arguments as in the previous Office action.

Huang was applied as in the rejections under 25 U.S.C. § 102(e), and as showing a heat spreader made of metal (claims 2 and 11). Brestel is relied upon as teaching treating the undersurface of a copper layer to form a black copper oxide layer (claims 2, 3, 6, 11, 12 and 15); for teaching a range of black copper oxide layer thickness (claims 4, 5, 8, 9, 13, 14, 17 and 18); and for teaching micro-etching the copper undersurface of a copper layer (claims 7 and 16).

These rejections are again traversed.

Brestel is directed to forming an electrically conductive pattern in a copper foil on a dielectric substrate, as for example in manufacture of printed circuit boards. The **copper oxide film is eventually removed in the Brestel process**, and **the copper foil is eventually etched completely through to form the pattern.** The oxide layer as described in Brestel is a sacrificial layer, not employed in the finished product.

In contrast, according to Applicants' invention, the black copper oxide layer is formed on the underside of the heat spreader as **a structural feature of the completed package**; it is there **to enhance the adhesion between the surface of the heat spreader and the underlying molding.** And, in contrast, according to Applicants' invention, **micro etching is carried out only to an extent sufficient to chemically roughen the surface of the copper heat spreader, again to enhance the adhesion between the heat spreader surface and the underlying molding.** (Applicants' page 7, paragraph [0030].)

This point is amplified as follows: **claims 2 and 11 are amended** to recite -- the black copper oxide layer enhancing adhesion between the undersurface of the heat spreader and the mold compound -- to emphasize that the black copper oxide of Applicants' invention is a part of the finished product.

The oxide layer as described in Brestel is a sacrificial layer, not employed in the finished product, and has nothing to do with adhesion. Accordingly, the person of ordinary skill in manufacture of semiconductor packaging would not look to Brestel to combine with Huang to make Applicants' claimed combinations.

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Moreover, Brestel fails to teach the claimed process elements that Huang lacks, as discussed above. Accordingly, no combination of Brestel and Huang makes Applicants' claimed invention, and the rejections for obviousness over combinations of Huang and Brestel should be withdrawn.

Examiner Coleman agreed in the Telephone Interview that there is no motivation to combine Brestel with Huang. Accordingly, the rejections of claims 2 - 9 and 11 - 18 over Huang in view of Brestel should be withdrawn.

In view of the foregoing, all the claims now in the application, namely claims 2 - 18, are believed to be in condition for allowance, and action to that effect is respectfully requested.

This Response is being filed within the first month following the three months' shortened statutory period set by the Examiner for response to the Office action and, accordingly, it is accompanied by a petition for one month's extension of time and a fee or fee authorization therefor. In the event the Examiner may determine that an extension of time may be required in connection with the filing of this paper, petition is hereby made therefor, and the Commissioner is authorized to charge any additional fee (or to credit any overpayment) to Deposit Account No. 50-0869 (CPAC 1014-4).

If the Examiner determines that a conference would facilitate prosecution of this application, the Examiner is invited to telephone Applicants' representative, undersigned, at the telephone number set out below.

Respectfully submitted,

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